Univ. of Kansas

RADAR SENSING FOR GEOSCIENCE PURPOSES

Monthly Progress Report, CRM 61-11
NASA Contract #NSR 17-004-003
1 June 1965 to 1 July 1965

Compiled by: J. W. Rouse, Jr.

Approved by: R. D. Ellermeier

R. D. Ellermeier
Associate Project Director

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I. INTRODUCTION - This report details activity for the month of June 1965 on the program "Radar Sensing for Geoscience Purposes," Contract #NSR 17-004-003.

II. GENERAL COORDINATION - On June 10-11, 1965 the Third Radar Team Coordination Meeting was held in Lawrence, Kansas. The purpose of the meeting was to obtain status reports on current activities among team members, and to review the spacecraft radar experiment proposals. The major decision made at this meeting involved the creation of an Executive Panel to deal with specific problems needing immediate decisions.

The Executive Panel of the Radar Team met in Chicago June 24. R.K.Moore, Chairman of the Executive Panel, and D. S. Simonett attended the meeting representing the University of Kansas. It was decided at this meeting that W. M. Brown of the University of Michigan will begin the preparation of the functional specifications for the radar sets to be used in the orbiting research laboratory vehicle.

On June 24, J. W. Rouse met with Reed Maes and T. Hayosh of the University of Michigan at NRL in Washington. Discussions were held with NRL representatives Frank Macdonald, N.W. Guinard, J. Ransome. The University of Michigan radar camera recorder will be delivered to NRL the first week in August. NRL personnel will be available to install this equipment beginning August 16. It is thought that some imaging flights can be made in the eastern area prior to Macdonald's trip to Puerto Rico for I. Katz in September.

III. TASK A - DECLASSIFICATION

B. Scheps has forwarded a request to DOD that the AN/APQ-55 radar set, and imagery taken with this system over non-classified areas, be declassified. The request is being reviewed at that level.

B. Scheps has requested small portions of AN/APQ-97 imagery be declassified. Additional AN/APQ-97 imagery will be forwarded to him for declassification.

Portions of APS-73 imagery are being considered for declassification by B. Scheps.

IV. TASK B - GEOSCIENCE

At the Radar Team meeting June 10-11, CRES geoscience personnel presented short status reports.

S. Morain has completed a preliminary comparison of stream and road patterns using the AN/APQ-97 imagery and large-scale soil maps of Woods County, Oklahoma. Other comparative maps will include road density and type, number of houses, location and number of oil wells. He also finalized general operating procedures for densitometry and has rationalized a method of calibrating antenna patterns. It is now possible, with some confidence, to correlate densitometer transmission data from one radar system to another or from one flight to another using the same system and calibrating against a number of farm ponds. Additional studies are continuing.

P. Norton completed soil association maps of Woods County, Oklahoma soil maps for comparison with radar imagery. Various soil units have been generalized into larger and more workable classifications. He has assisted S. Morain in the Woods County, Oklahoma area by mapping drainage nets, delineating escarpment features and preparing sand dune and alluvium map of Woods County, based on radar imagery.

D. Williams has been analyzing densitometer transmission data from aerial photograph negatives for the October, 1965 AN/APQ-97 Garden City, Kansas flight. He also has been preparing soil association maps in various south central Kansas counties for comparison with AN/APQ-97 radar imagery.

R. Walters and J. Kirk made field studies in the Waldron, Arkansas area field checking the APS-73 imagery. Despite heavy vegetation, a thick soil cover and moderate relief (which has caused large amounts of radar shadowing) the conclusion may now be drawn that geologic information relating to continuity of beds and regional interpretation of structure can readily be obtained from this imagery. A number of major transverse-to-structure fracture systems not noted in the literature are apparently detected on this imagery and are under study. Kirk and Walters also visited Texas Instruments on June 25 in Dallas, Texas, where they examined APQ-56 and APQ-86 imagery of the Arbuckle Mountains. They also conferred with Mr. Leonardo of TI's staff concerning the company's remote sensor program and their future missions.

J. Eagleman continued field and laboratory studies at the Garden City site, western Kansas.

D. Simonett carried out field studies in Oklahoma and Kansas related to the use of AN/APQ-97 imagery for soil association mapping.

V. TASK C - RADAR AND LABORATORY MEASUREMENTS

Ohio State conducted radar and radiometry tests at the Purdue University agricultural site this month. Radar cross-sections of oats, wheat, and alfalfa were measured at S-, X-, and K_u-band. The radar return differences between horizontal and vertical polarizations were found to distinctly depend on the crop type. The distinguishing qualities of the signal polarization had also been indicated earlier during the calibration checks at Columbus, Ohio. The Ohio State crew departed for field tests during the last week in June.

The SO-8 and APS-15 radars being mounted at the top of a dormitory at the University of Kansas are in final checkout stages. The APS-15 unit has been tested and appears to be operating satisfactorily. The SO-8 unit is expected to be operating within a week. The experiment is scheduled to commence shortly after August 15. The installation is awaiting the arrival of miscellaneous hardware. A modification to the pulse width of the SO-8 must be made prior to initiating tests.

In April a preliminary examination of radar as applied to sea state was made with the KU acoustic facility. Based on the initial observations a more elaborate and reliable test facility has been prepared. A stable transducer carriage positions the transducers under the surface of the water at controlled angles and depths. A wave height indicator has been constructed and mounted on a stable platform. Measurements are in progress.

VI. TASK D AND E - RADAR FLIGHT TESTS AND NEW TECHNIQUES

A design study is presently under way on a Fresnel zone plate on-board processor to be used with synthetic aperture radar. This device will be constructed and used with signal film procured from presently operational synthetic aperture systems and also with an acoustically simulated synthetic aperture system which is also in the design study state at the University of Kansas. The radar simulator will allow a detailed study of the operation of synthetic aperture systems and will

provide a much more convenient method of evaluating new techniques than presently exists in the synthetic aperture field.

NRL radar data taken over Pisgah Crater is presently being used as sample data in the development of a set of computer programs which treat radar data as a linear decision problem. The purpose of this investigation is to arrive at a standard technique for further analysis of radar data, and evaluate the usefulness of linear decision theory for scatterometry analysis.

The University of Michigan is nearing completion of its modification of a 35 mm CRT recorder to be used with the NRL radar system. Additional input logic, a 10 mc video amplifier, and sweep circuits have been designed and constructed. The week of August 2 will be used to train NRL personnel in the operation of the equipment. The recorder will be installed the week of August 16, 1965.

The NRL antenna pattern imposes difficult requirements on the recorder because of the large doppler history. This has limited the range sweep to approximately 9 μ sec at X- and C-band. This corresponds to about one mile swath width. The P- and L-band sweep is 70 μ sec. The University of Michigan monthly progress letter is Appendix B.

VII. TASK F - SPACECRAFT EXPERIMENT PLANNING

The University of Michigan has undertaken the preparation of functional specifications for the radars proposed in the earth orbital and lunar orbital spacecraft. A decision is yet to be made on the use of a 35 gc imaging radar system as to whether or not it should be a brute-force or unfocussed synthetic aperture radar.

APPENDIX A

Ohio State University, Antenna Laboratory
Monthly Status Letter, Contract NSR-36-008-027

The following work was accomplished during the month of June.

The equipment has been rechecked and final system calibrations were accompliched. Some time was spent in adapting the truck van for barge transportation while at the west coast sites.

A shake-down trip to Purdue University was made during the middle of this month. The radar cross section of oats, wheat, and alfalfa were measured at S-, X-, and K_u-band. The measurements were taken at both vertical and horizontal polarizations. Although the data have not yet been fully analyzed, interesting features have been noted. The signal return level was different for each crop, and it also varied as a function of the angle of incidence. For example, the vertical component at K_u-band was a maximum at about 40^o for oats while a minimum was obtained at 50^o for wheat and a somewhat linear dependence was seen for alfalfa. A 8-1/4 inch metallic sphere served as a standard reference for all cases and frequent checks were made during the measurements.

The 8.6 mm radiometer was also used to measure the three crops. Its performance was satisfactory with some minor mechanical difficulties which have since been remedied. The data from this phase is still being analyzed.

The truck and engineers departed for the field sites during the last week of June.

Benedickt A. Munk
Research Associate

APPENDIX B

The University of Michigan, Institute of Science and Technology
Monthly Progress Letter, Contract No. CRES-61-2

This monthly progress letter is the first of a series which will briefly describe the work performed on Contract No. CRES-61-2 (U of M Project No. 7390) between The University of Michigan and The University of Kansas. This report will cover the period through 30 June 1965.

The objective of the contract is to assist The University of Kansas and the Naval Research Laboratory in obtaining radar data as a function of frequency and polarization. This will be accomplished by furnishing CRT camera recorders to an existing four frequency radar, and then analyzing the recorded results in an optical processor. The efforts, to date, have involved modifying a 35 mm CRT recorder to make it compatible with the parameters of the NRL radar and also to specify the various working parameters of the recorder and the radar to allow optical processing of the recorded data.

Phase I - Modification of 35 mm Camera Recorder

The 35 mm recorder is undergoing modification to allow four sections of radar data to be recorded simultaneously. This has involved design and construction of a 10 mcs video amplifier, the input logic for the sweep circuits, and the sweep circuits. This work has been completed with the exception of the final packaging of the input logic for the sweep circuits. Additional modifications have been made in the CRT electronics to improve the reliability and stability of the circuits over that of earlier design.

The 35 mm camera recorder will be completed and operational during the first week of August to allow training of NRL personnel in the use and maintenance of the recorder. It is planned, at this time, to use the week of August 2 through 6, 1965 for this training period. The recorder will then be shipped to NRL for installation the following week.

Phase II - Data Generation and Optical Processing

The flight experiments that can be performed with the NRL radar and CRT camera recorder depend on the characteristics of the radar, the recorder and the optics of the processor. The characteristics of the radar that define its synthetic aperture capabilities are the antenna patterns, the antenna positioning, the vehicle

speed, the repetition rate and the radar wavelengths. Of these, the antenna pattern with its resulting doppler history is the main item that causes difficulty when designing the flight experiment. Compromising of other system parameters is required to allow optical processing, particularly at the two higher frequencies.

It is presently planned to use a 9 microsecond sweep for each range increment in the X and C band mode, and 70 microsecond sweep for each range increment in the P and L band mode. A more complete analysis of the system problems and the options available for increasing range increments will be presented in the next progress letter.

Reed E. Maes, Jr.
Project Engineer